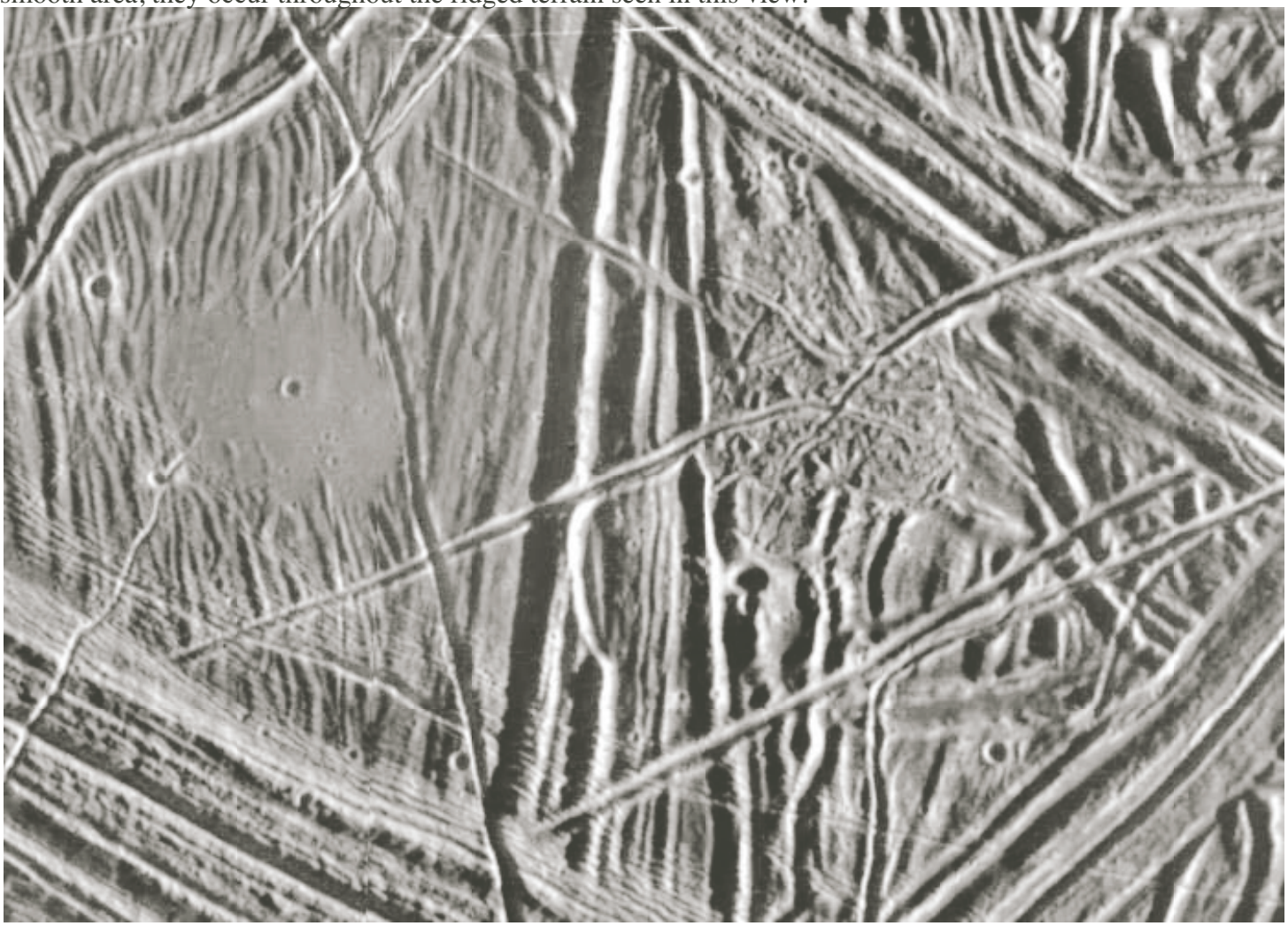
Relative Age Relationships Exercise
Galileo Mission to Jupiter: Europa Images P-48507 and P48527

This is an exercise in relative age relationships using two recent Galileo Mission images. It uses reading comprehension, image analysis, and some logical reasoning skills to sort out relative age relationships. Here, it is presented as a class exercise followed by an individual exercise, but it may be presented as an entirely individual exercise, with the first image done as an example. Less advanced students may be asked only the age of one unit versus any other, while more advanced students could be asked to do some of the sketch maps themselves after an introduction.

Materials: Images
Optional: Tracing paper and colored pencils
(or a computer graphics program such as macpaint or photoshop for more advanced technology classes. Download images from the NASA Galileo web site for this version)

Image Source and Size: The image below is a close-up view of the icy surface of Europa, a moon of Jupiter. It was obtained on December 20, 1996, by the Solid State Imaging system on board the Galileo spacecraft during its fourth orbit around Jupiter. The view is about 13 kilometers by 18 kilometers (8 miles by 11 miles) and has a resolution of 26 meters (28 yards). The Sun illuminates the scene from the east (right).

General Description: A flat smooth area about 3.2 kilometers (2 miles) across is seen in the left part of the picture. This area resulted from flooding by a fluid which erupted onto the surface and buried sets of ridges and grooves. The smooth area contrasts with a distinctly rugged patch of terrain farther east, to the right of the prominent ridge system running down the middle of the picture. The rugged patch of terrain is 4 kilometers (2.5 miles) across and represents localized disruption of the complex network of ridges in the area. Eruptions of material onto the surface, crustal disruption, and the formation of complex networks of folded and faulted ridges show that significant energy was available in the interior of Europa. Although small impact craters are most easily seen in the smooth area, they occur throughout the ridged terrain seen in this view.



Pick a partner you have not worked with yet, and work through the relative age exercise on this page.

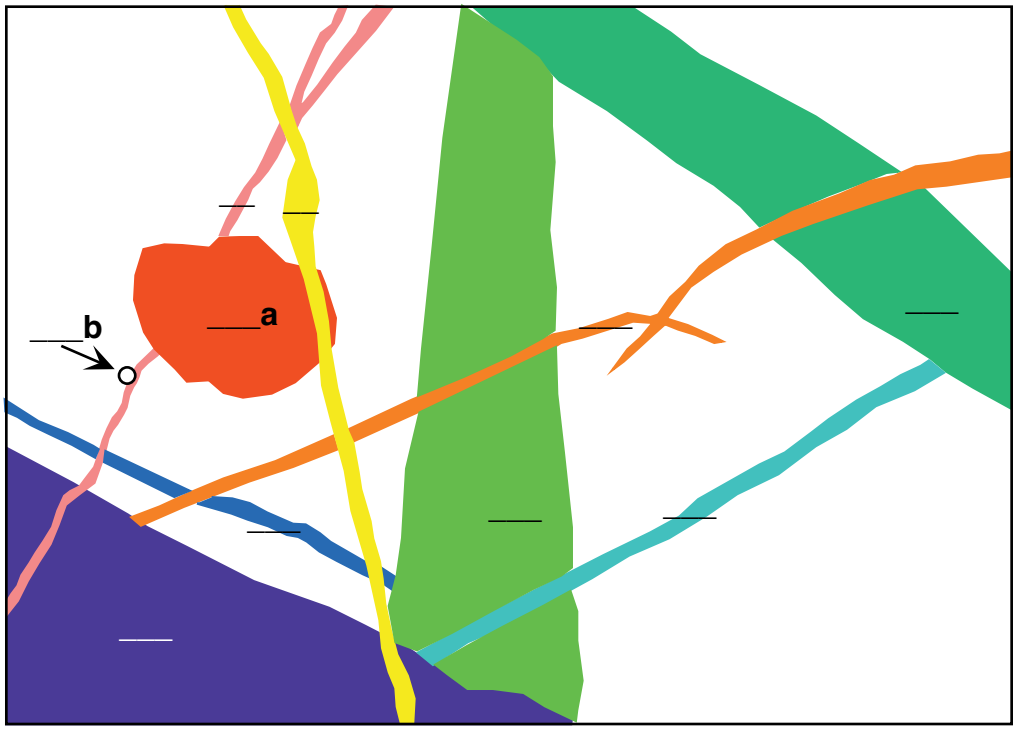
Since no vegetation or atmosphere is present, the clarity and complexity of this image lend themselves well to explaining and exploring superposition relationships. Superposition relationships are fundamental in geology for determining relative and absolute ages (relative and absolute ages is a required topic several different sets of education standards, such as the MD core learning goals). Superposition is summed up by the following :

> Oldest events and strata (layers) are normally at the bottom of a unit.
> Youngest events and layers are normally at the top.

To use superposition relationships to determine the sequence of events in a region, simply use the following statement to sort out the event order.

> *Younger events or layers crosscut or lie on top of older events or layers*

For example, the sketch to the right shows ten features picked out of the Europa image.



From cross-cutting relationships, order them in their relative ages from youngest to oldest, with 1 the youngest, and 9 the oldest (write the numbers on the black lines on each feature).

Two of the features have the same number (followed by a or b), as we cannot tell which of the features is younger, just that they both cross-cut another feature. Feature __a is a small volcanic edifice. Feature __b is a small impact crater. The remaining features are faults or divergent boundaries or both.

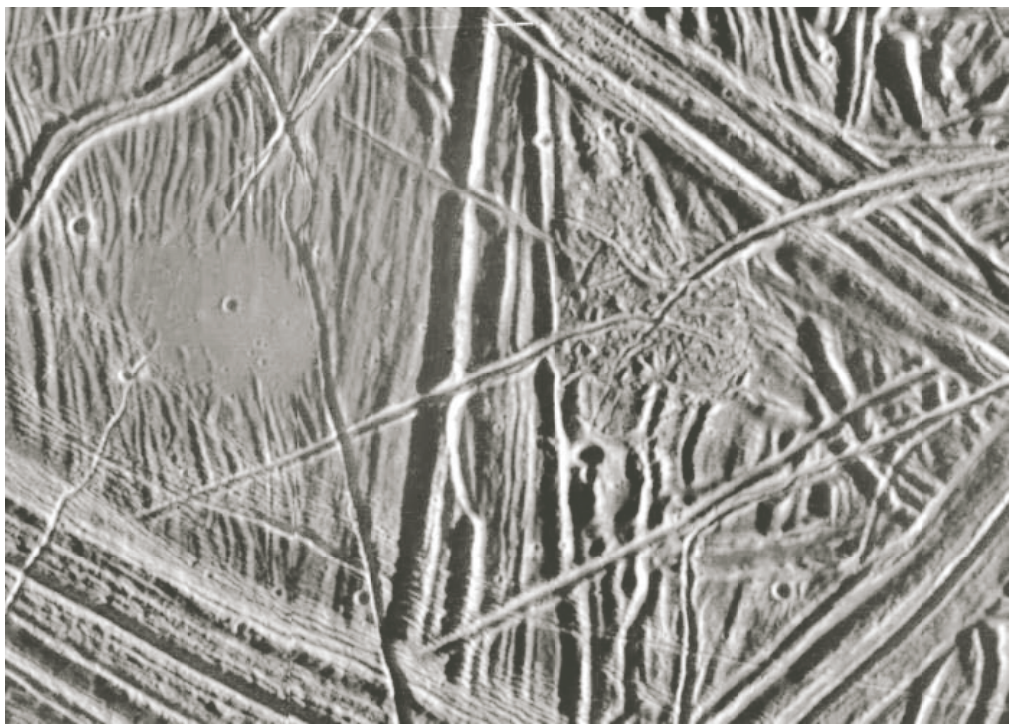
If you are having difficulty seeing how to sort out relative age, list each feature in relation to those it intersects with with statements like the following:

The red feature is crosscut by the yellow feature.

The dark blue feature is crosscut by the green, orange, pink, and yellow features.

The light blue feature is crosscut by the teal (blue-green) feature.

Then, put the statements in order, with the features that are youngest first (on top, or cross cut by the least number or features). The image and questions on the next pageshould be finished as part of your homework assignment.



P-48507
This complex terrain on Jupiter's moon, Europa, shows an area centered at 12 degrees north latitude, 274 degrees west longitude, in the trailing hemisphere. As Europa moves in its orbit around Jupiter, the trailing hemisphere is the portion which is always on the moon's backside opposite to its direction of motion. The area shown is about 100 kilometers by 140 kilometers (62 miles by 87 miles). The complex ridge crossing the picture in the upper left corner is part of a feature that can be traced hundreds of miles across the surface of Europa, extending beyond the edge of the picture. The upper right part of the picture shows terrain that has been disrupted by an unknown process, superficially resembling blocks of sea ice during a springtime thaw. Also visible are semicircular mounds surrounded by shallow depressions. These might represent the intrusion of material punching through the surface from below and partial melting of Europa's icy crust. The resolution of this image is about 180 meters (200 yards); this means that the smallest visible object is about a quarter of a mile across.

The sketch below highlights several features with cross-cutting relationships, and a fill-in-the-blanks list from youngest to oldest. Several features have the same or similar ages from cross-cutting relationships. Please fill in the blanks with the letters. Which features would you need absolute age dates for to resolve which of each pair of features is younger? _____

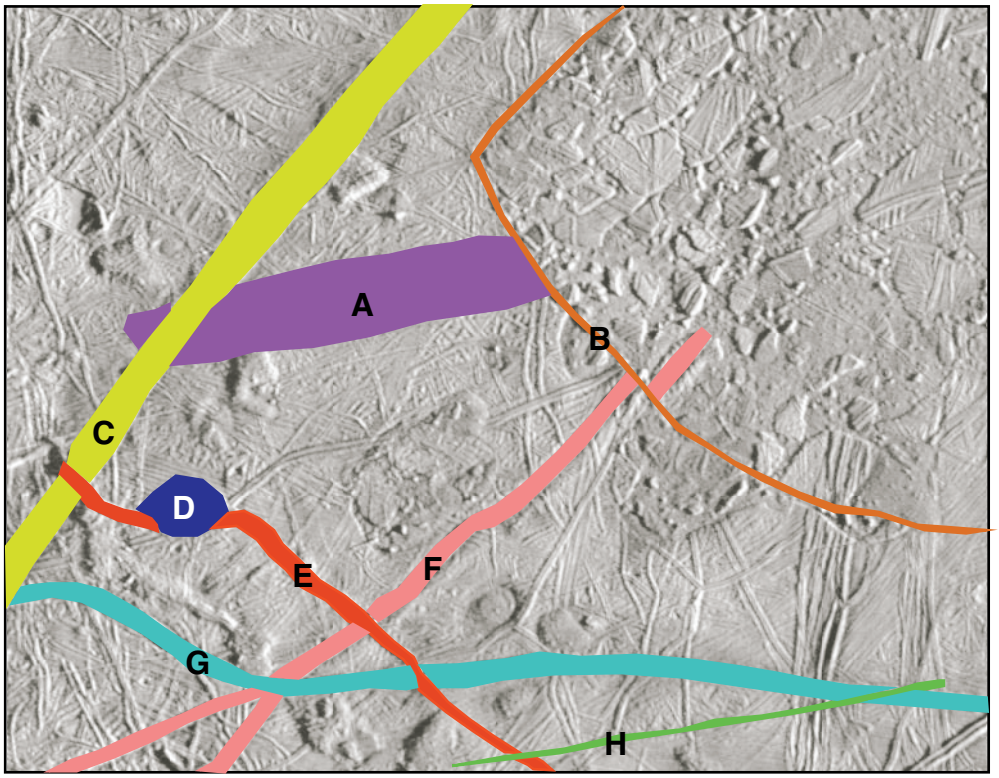
Youngest _____ **and** _____

_____

_____**and** _____

_____**and** _____

Oldest _____



Key for class exercise